Physical and Chemical Monitoring in Loxahatchee National Wildlife Refuge: Impact of Canal Sediments on Water Quality

Purpose and Need: Impact of stream sediment on surface water quality has been an area of active water-science research (Bostrom et al. 1988; Brunke and Gonser 1997; Brunke et al. 1998; Dahm et al. 1998; Daroub et al. 2003; DiToro 2001; Grimm and Fisher 1984; Perkins and Underwood 2001; Vollmer et al. 2002; Waldon and McCormick 2003). The impact of pollutant-rich sediments being entrained into surface water is of national and international interest. The research project described here will further increase the understanding of these mechanisms. Results of these studies will provide state and federal managers of wetland hydrology with needed understanding of the importance of these processes in the Everglades, Everglades Agricultural Area, and in similar wetlands worldwide.

The Arthur R. Marshall Loxahatchee National Wildlife Refuge includes one of three areas in South Florida designated to maintain water storage, provide flood control, and provide a refuge for the remnant Everglades ecosystem. In the 1950s and 1960s the Refuge was surrounded by perimeter canals and hydrologically isolated from its watershed by levees. Stormwater runoff, primarily from the Everglades Agricultural Area, is pumped into the perimeter canal where it may flow to discharge structures or mix into the rainwater-dominated interior wetland. Nearly a half-century of high-phosphorus highly organic sediments have accumulated in the L-40 Canal to a depth of several feet (Daroub et al. 2003; Daroub et al. 2002; Diaz et al. 2004). Diaz et al. (2004) estimated that over 850 metric tons (1000 Kg per metric ton) of phosphorus are sequestered in the Refuge perimeter canals, with over 300 metric tons in the L-40 Canal. For comparison, loading of phosphorus entering the Refuge from Stormwater Treatment Area 1 East (STA-1E) has been projected to be 8.4 metric tons per year (Goforth and Piccone 2001) with an outflow concentration of 50 ppb phosphorus. Thus, entrainment of canal sediment phosphorus could severely delay full realization of the water quality improvements anticipated to result from STA construction.

As documented in USFWS comments to the Florida DEP regarding the STA-1E NPDES permit application, the USFWS is concerned that sediments in the L-40 Canal may be suspended into the water column by relatively high velocities associated with STA-1E discharges. This could mobilize phosphorus and allow its transport into Refuge wetlands. These sediments are potentially a very large source of phosphorus that might become available (Daroub et al. 2002).

Project Description: The project described here will provide a new component that will integrate with existing monitoring performed by the Refuge (Brandt et al. 2004; USFWS 2003) and others including the UF investigators. This project is divided into two components. Component A will monitor changes in the surface elevation of sediments within the L-40 Canal prior to and following commencement of discharge from the STA-1E discharge pump station. Component B will study changes in water quality by following and sampling water as it flows along the L-40 Canal. It is conjectured that water flow induced by the STA pump station or other sources may, at times, entrain sediments resulting in erosion of the sediment surface and deterioration of water quality at downstream sampling sites. These studies will provide a better understanding of conditions that can result in deterioration of water quality. This study and

associated activities may identify the need for adaptation of STA discharge operations or for additional structural changes (*e.g.*, dredging).

COMPONENT A: Hydrographic surveys of L-40 Canal near the STA-1E discharge

Experimental Design: Five canal cross-sections, 3 below and 2 above the STA-1E discharge channel, will be marked by posts permanently installed in the water on both sides of the L-40 Canal at each site (care will be taken to create no hazard to navigation). Site locations should, as far as possible, reoccupy sections measured by Daroub et al. (2002). Relative water surface elevation will be determined by staff gage mounted on or near one post, or by tapedown measurements from a mark on the post to the water surface, at each section at each visit. Stage at the 1-8C gauge will be recorded for reference, but is not adequate to determine water surface elevation at the sites because wind or flow may cause a significant surface slope in the Canal. Depth to sediment from the water surface will be measured from a boat. Lateral distance across the Canal will be measured along a taut cable extending between the posts. The cable will be attached to an anchor stake, pass over a nail or hook on the post, extend across the Canal, and be similarly anchored on the opposite bank. The cable will be ruled with distance measurements, and, as a safety measure, visibility of the cable will be enhanced using flagging tied to the cable. Initial measurements will be performed at 2 to 5 foot intervals across the section to provide at least 30 measurements. Subsequent surveys will measure at 5 standardized locations (perhaps 30, 40, 50, 60, and 70 feet from the interior post) across the section. Depth to sediment relative to the arbitrary datum of the staff gauge or mark on the post will be calculated for each measurement by subtracting measured depth from surface water elevation, or adding depth to the tapedown reading. Measurements will be performed at least six times per year (approximately bimonthly) over three years. All measurements should be estimated and recorded to the within 0.01 foot (3 mm) where possible.

Task A.1: Development of sediment study work plan and generic survey planning document.
In cooperation and collaboration with DOI personnel, the researchers will develop a sediment study work plan and a generic sediment survey-planning document that, so far as possible, provides guidance for individual survey planning. The documents will include methods, location selection, selection of sampling dates, equipment needs and equipment sources, personnel needs, scheduling requirements, and procedures for field documentation.

Task A.2: Implementation of sediment field surveys
Initial plans are for six surveys per year (approximately bimonthly) to be performed over a three year (36-month) period. Surveys will follow the plan and experimental design described here unless all parties agree upon modifications. If needed and contingent on availability, Refuge personnel will assist the researchers in field sampling.

Task A.3: Sediment study reporting.
A sediment survey plan and report will be prepared for each survey. The report will list all data and observations taken during the survey. The survey reports will also describe any activities that differed from the survey plan. Together the survey plan and report should completely document

the survey activities and data for each survey. A final summary project report will also be submitted. Researchers are encouraged, but not required, to publish findings in peer-reviewed journals.

COMPONENT B: Synoptic water quality research studies of L-40 Canal

Experimental Design: This project will survey water quality and other relevant parameters in the L-40 Canal on selected dates. Each water quality survey, termed an "intensive" or synoptic" survey (Mills et al. 1986), will sample sites upstream and downstream of the STA-1E outfall. These data will be used to evaluate the relationship of water quality to canal water velocity, as well as effluent and marsh water quality. The studies will also provide a basis for water quality model calibration to be performed in a separate project.

Task B.1: Development of water quality study work plan and generic survey planning document.
In cooperation and collaboration with DOI personnel, the researchers will develop a water quality study work plan and a generic survey-planning document that, so far as possible, provides guidance for individual survey planning. The documents will include methods, sampling location selection, water quality parameters, selection of sampling dates, equipment needs and equipment sources, personnel needs, scheduling requirements, and procedures for field documentation. The planning documents will also list chemical analyses to be performed on water samples. At a minimum these include total suspended solids, turbidity, chloride, and total phosphorus. Where feasible, surveys will follow a Lagrangian (plug-flow) sampling design that makes observations and draws samples based on time-of-travel to each sampling site.

Task B.2: Implementation of field surveys
A minimum of seven surveys will be performed over no more than a 20-month period. At least 2 of these studies will be performed, if feasible, prior to STA-1E initiating substantial discharge. If needed and contingent on availability, USFWS personnel will assist the researchers in field sampling. It is anticipated that each survey will sample at 5-6 sites.

Task B.3: Reporting.
A water quality survey report will be prepared for each survey listing all data and observations taken during the survey. The survey reports will also describe any activities that differed from the survey plan. Together the survey plan and report should completely document the survey activities and data for each survey. A final summary project report will also be submitted. Researchers are encouraged, but not required, to publish findings in peer-reviewed journals.

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